

DESALINATION - PRODUCING POTABLE WATER

Desalination, the process of removing salt, other minerals, or chemical compounds from impure water, has provided a limited source of potable water for some of California's communities. The issue for ocean resource managers is the desalination of ocean water for delivering potable water to coastal and island communities whose ground and/or surface water supplies have been reduced or eliminated. Water shortages may be the result of events such as droughts, contamination, salt water intrusion, or limited water sources, even after water conservation methods have been implemented. Thus, desalination has received increasing attention in drought years when water supplies become greatly threatened or diminished. In above-average water years, permit requests for desalination facilities are infrequent. The current drought-response approach to desalination forces government agencies to conduct expedited review of these facilities during scarce water periods. Currently, neither the State nor most local governments have long-term planning mechanisms regarding use and potential environmental impacts of desalination plants for potable water production.

BACKGROUND

Desalination is often misunderstood to mean only the removal of sodium chloride (salt) from brackish or salt water, yet with today's technology desalination can virtually remove any mineral and most biological or organic chemical compounds. More appropriate terms for desalination might be "de-mineralization" or "purification" of water. Discharges to ocean and coastal waters from desalination plants is a concern for ocean resource management.

Desalination facilities use two basic technologies to extract potable water from seawater. Reverse osmosis works by forcing seawater through a semipermeable membrane, which restricts salt and other minerals, but allows water molecules to pass through. The second method is distillation where seawater is heated to produce steam, which is then condensed to produce water with a low salt concentration and few of the other impurities contained in the original water. Depending on the technology used, the final water product is generally high quality, ranging from 1 to 500 parts per million total dissolved solids (the recommended California drinking standard for total dissolved solids is 500 milligrams per litre maximum, which is equivalent to 500 parts per million).

Desalination plants located in the coastal zone fall under the jurisdiction of the California Coastal Act, administered by the California Coastal Commission (Coastal Commission). If a facility were to be proposed in the San Francisco Bay Area, it would fall within the jurisdiction of the San Francisco Bay Conservation and Development Commission. Discharge of liquid brine waste from desalination operations is regulated under the 1987 amendments to the Clean Water Act through the National Pollutant Discharge Elimination System (NPDES) administered by the State's nine Regional Water Quality Control Boards (RWQCBs). In addition, the RWQCBs issue Waste Discharge Requirements through Porter-Cologne Water Quality Control Act authority. Other State agencies having some role over the planning, environmental review, or operation of desalination plants include air quality management districts; the California Energy Resources, Conservation and Development Commission; and the California Departments of Fish and Game, Water Resources, and Health Services.

ISSUE ANALYSIS

Desalination provides water for domestic purposes, industrial processing, parks and agricultural irrigation, power plant applications, and recharging of groundwater supplies. Desalination can provide significant

benefits to communities along the coast that have depleted or limited access to traditional ground and/or surface water supplies. However, certain characteristics about desalination make it an extremely costly technology.

Capital investment and operations are expensive for all desalting options because pipes and equipment require corrosion-resistant materials, while special pretreatment filters and cleaning membranes require frequent backwashing to remove the rapid accumulation of solids. In addition, chemicals must be used in the pretreatment of the source water and de-fouling chemicals must be used to remove organisms in reverse osmosis systems if sea water is directly pumped into the plant. Chemicals used to clean the system and solid wastes generated from the process must be disposed of properly.

The efficiency of desalination is between 15-50%; in other words, 15-50 gallons of potable water are produced for every 100 gallons of seawater. The remaining water consists of brine and dissolved solids. The energy required to produce this potable water from seawater by reverse osmosis is approximately 2,500-12,000 kilowatt hours per acre-foot, depending on the quantity of salt in the intake water. (California Coastal Commission 1993). This high energy requirement for facility operations combined with high capital investment results in water costs substantially exceeding costs for traditional water sources. For example, the cost of producing potable water through desalination ranges between \$1,300-\$2,200 per acre-foot, depending on its salt content and necessary pretreatment. In contrast, the Metropolitan Water District of Southern California water costs range between approximately \$195 per acre-foot for imported water and up to \$300 per acre-foot for water delivered by the district to some of their customers (Long, pers. comm.).

Depending on the design and location of the plant, environmental effects associated with desalination processing can include construction and operation impacts on marine wildlife and plants, water quality, air quality, and recreational uses. Often the most significant of these impacts is to water quality and, subsequently, aquatic species. Solid wastes and/or toxic metals are also generated in lesser quantities. Disposal of liquid brine waste may involve: (1) direct discharge into the ocean, (2) combining the waste with sewage treatment plant wastewater or with power plant cooling water before discharging into the ocean, (3) drying brine to make salt or disposing in land fills, (4) underground injection, or (5) discharging into a sewer for treatment by a sewage treatment plant (for brackish water systems only).

Due to the high cost and energy demand of the desalination process, it is rarely the first choice as a water supply alternative. Therefore, desalination facility proposals are generally not made when conventional water sources are available or when supplies can be maintained through reasonable conservation measures. Evaluations of water supply alternatives needed to supplement existing sources are beginning to include desalination technology more often. This is primarily due to the rising costs to construct, operate and maintain conventional water treatment and conveyance systems (i.e. surface reservoirs) and recent cost improvements in desalination technology.

Recent technical improvements in desalination technology, such as more effective cleaning compounds and membranes which require less pressure, have improved its competitive position in comparison to traditional water treatment and supplies. When located with a power facility, desalination can produce potable water from seawater for less than \$1,000 per acre-foot and potentially as little as \$500 per acre-foot (California State Assembly 1990). For impaired water, such as agricultural drainage, industrial waste, or treated wastewater, the cost for desalination could be much less. Blended with other water sources, the cost of desalinated water can be further reduced, although it is still relatively high compared to traditional water sources. Desalination can also be compared to other "alternative" water source prices and the future cost of rationing or even running out of water. For example, when compared to the price of bottled water in supermarkets, desalinated water is far cheaper. In evaluating the economic feasibility of desalination, communities must consider their ability to recover the capital costs of a facility that may lie idle for long periods of time when less expensive water sources are available.

Benefits of desalination for coastal communities include: (1) flexibility in facility size and source water, (2) minimal reliance on extended delivery systems, (3) the opportunity for local control of water supplies, (4) reduced dependence on inland water sources, (5) relatively high quality potable water, and (6) a reliable water source even in times of drought. The 1993 Coastal Commission report *Seawater Desalination in California* identifies 12 existing or approved desalination facilities on the mainland coast, offshore oil platforms, or offshore islands. The report also identifies 19 desalination facilities that are being considered or have been proposed along the coast. Figure 5-1 identifies the most recent information about existing and proposed desalination facilities along the California coast.

Recent federal legislation (SB 811, Simon) authorizes \$180 million for research into reducing the cost of converting saltwater to fresh water. The measure authorizes spending \$5 million per year through 2002 for desalination research and \$25 million annually during the same six-year period for demonstration and development projects. The price of traditional water supplies is gradually increasing and this research could result in future decreases in the cost of producing potable water from saltwater sources (International Desalination Association Newsletter, Sept./Oct. 1996). Future research may also address the environmental impacts of this technology, in addition to addressing cost and efficiency issues. Governor Wilson acknowledged the differences in pricing between desalted water and traditional sources in his 1992 *California Water Policy - A Strategy for the Future*. However, this policy also indicates desalination costs are being reduced over time, particularly for brackish ground water desalination in some parts of the San Joaquin Valley and Southern California. He states that California is committed to helping local agencies with permits and technical assistance to advance the use of desalting where it is cost effective.

City of Santa Barbara - A Case Study

The City of Santa Barbara desalination facility provides an interesting case study to help demonstrate some of the environmental, economic, and permitting issues that arise from desalination facilities. Santa Barbara had been experiencing severe water shortages resulting from the statewide drought and was in need of a dependable water source. Many technologies and ideas were investigated, including proposals to use tankers to bring fresh water from sources as far away as British Columbia. After an exhaustive review of alternatives, the City Planning Commission approved a coastal development permit in March 1991 for the onshore portion of a temporary desalination plant. In May 1991, the Coastal Commission approved a coastal development permit (with conditions) for installation of a liner sleeve in an abandoned ocean waste water outfall line and the for construction and operation of ocean intake structures and auxiliary facilities to service a temporary five-year facility with a maximum production capacity of 10,000 acre feet per year. The six permit conditions specified the life of the permit (5 years) and required a water quality monitoring program, submittal of an NPDES permit, a plan to reduce construction impacts, special measures to ensure navigation safety, and methods to assure the protection of archaeological resources in the area.

The temporary Santa Barbara facility was constructed and began operating in 1992 using reverse osmosis. The plant has a capacity of 7,500 acre-feet per year, enough to provide 21% of the average pre-drought water needs of the City of Santa Barbara, Goleta, and Montecito. The cost of the water to the City was projected to be \$1,918 per acre-foot, with the City's contract requiring capital costs to be paid within five years. Plant operations of five years or more were projected to result in reduced water costs.

The facility operated for three months to allow components testing but was then placed on long-term standby status due to increased reservoir supplies replenished by rainfall during the winter of 1992-93 and reduced demand resulting from implementation of water conservation best management practices recommended by the California Urban Water Conservation Council. Maintenance costs for the City of Santa Barbara and its partners, the Goleta and Montecito water districts, are \$775,000 annually to keep the plant on standby status. With the impending supply of State Water Project water to be delivered to Santa Barbara, Montecito and Goleta in 1997, the Santa Barbara City Council voted to decommission the plant for long-term storage at a cost of approximately \$772,000. Future maintenance is expected to be about

\$271,000 per year, and it is unclear whether the Goleta and Montecito water districts will contribute to the decommissioning or maintenance costs. Deactivation is not expected to increase water rates as the City's budget already allows for long-term upkeep.

The largest municipal facility of its kind in the United States, the City plans to go before the Coastal Commission for a permit to convert it into a permanent site. If necessary, the City has the ability to re-activate the facility at a projected cost of about \$2.9 million. However, recent studies have indicated that with existing supplies the desalination plant would not be used even if a drought occurred that was similar to the most severe on record for the South Coast, which lasted from 1946 to 1951. Customer demand should not exceed current supplies until well after the turn of the century, and State Water Project supplies will only advance that time frame. The City expects to achieve overall cost savings through long-term storage so long as the plant is not re-activated within the next seven years. (Roebuck, pers. comm.).

FINDINGS AND RECOMMENDATIONS

Finding

Desalination of seawater can be an important technology for ensuring a reliable coastal water supply; however, the conditions under which desalination is appropriate must be carefully identified and considered. Desalination has produced a limited source of water for some communities along the California coast, but due to its high costs and potentially adverse impacts on marine waters, desalination should be considered only after all other water sources, conservation measures, and long-term economic ramifications have been evaluated. The Governor's 1992 Water Policy provides that the State will help local agencies with permits and technical assistance to advance the use of desalting where it is cost effective.

Recommendation 5I-1. Establish criteria for determining when desalination of seawater is appropriate for supplying water, and when alternative water supply options are preferable. Water planning and regulatory agencies, and the private sector should work together to establish contingencies for developing this technology.

Finding

Desalination research sponsored by industry and the federal government in the past resulted in significant technical improvements for converting seawater into potable water. These improvements, especially to reverse osmosis membranes, have reduced the cost of this technology. However, desalination remains a relatively expensive potable water source and the environmental impacts are a continued source of concern. Although the California Ocean Plan Triennial Review and Workplan (October 22, 1992) identifies the need for additional research and policy evaluation of desalination alternatives, funding limitations in California have not allowed such actions to be implemented. Recent federal legislation (Simon, SB 811) has authorized up to \$180 million for a six-year period to support desalination research, demonstration, and development projects.

Recommendation 5I-2. The State of California should encourage the federal government and industry to help conduct and/or fund additional research on minimizing the costs and environmental impacts associated with the use of desalination to obtain freshwater supplies from saltwater. This research could be conducted by the federal government, the State Water Resources Control Board and the Department of Water Resources, California Sea Grant programs, California State University System, University of California,

public research institutes such as the Southern California Coastal Water Research Project, or private industry. Research should investigate key questions such as determining the best model for predicting brine plume impacts, monitoring those impacts on marine organisms, determining whether water quality objectives should be established for brine waste discharges, and addressing engineering/economic feasibility issues regarding this technology.